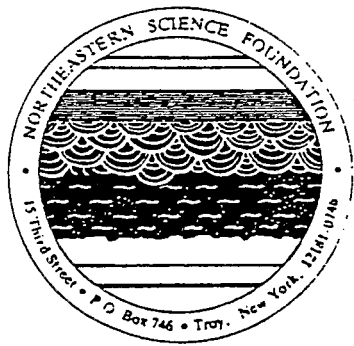
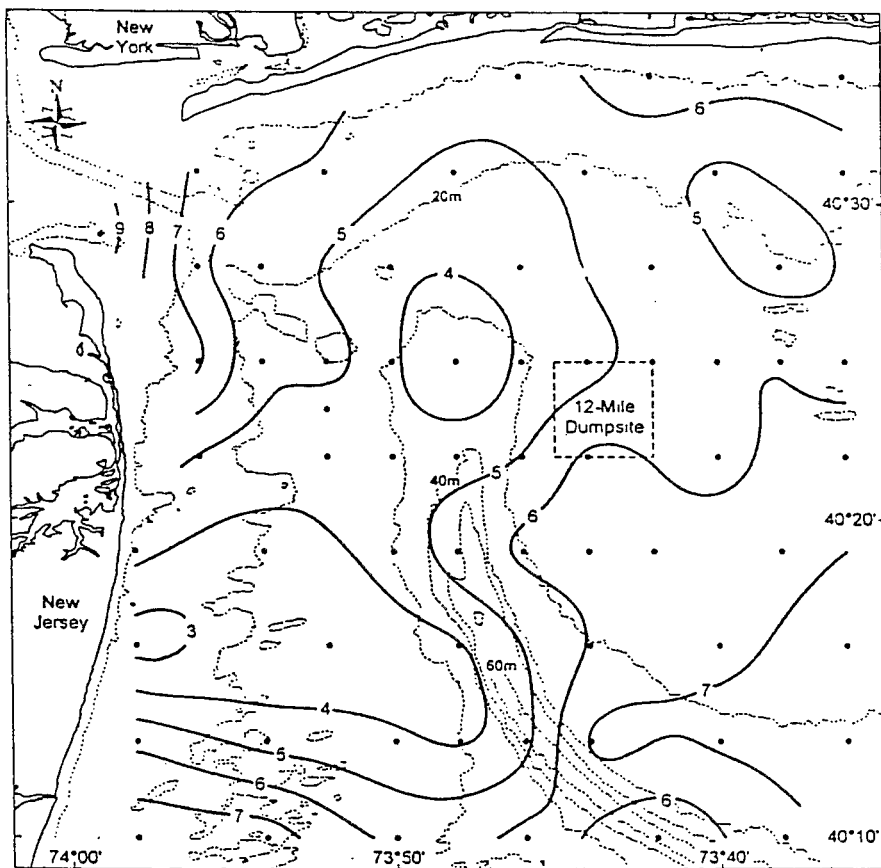


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DISPOSAL OF WASTES AND DREDGED SEDIMENTS IN THE NEW YORK BIGHT

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ABSTRACT: This paper provides an historical overview of ocean disposal activities in the New York Bight under the federal ocean disposal program established by the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 and modified by the Ocean Dumping Ban Act (ODBA) of 1988 and the Water Resources Development Act (WRDA) of 1992. The U.S. Environmental Protection Agency (EPA) is responsible for designating and managing ocean disposal sites, and for enforcing permit and statutory requirements. The U.S. Army Corps of Engineers (USACE) is responsible for issuing dredged material permits; EPA, for all other ocean disposal permits. Programs have included those for acid waste, industrial waste, cellar dirt, woodburning at sea, municipal sewage sludge, and dredged material. The volumes, geographic extent, duration, regulations, and current status of these disposal activities are examined. Historical trends include increases in scientific research, public concern and involvement, government oversight, and the use of non-ocean alternatives, as well as a dramatic decrease in ocean disposal activities.

INTRODUCTION

The purpose of this paper is to provide a historical overview of ocean disposal activities in the New York Bight over the last quarter century. In particular, it considers the federal ocean disposal program established in the early 1970s.

The New York Bight is named after the right angle bend in the Atlantic shoreline at the entrance to New York Harbor. The Bight consists of a part of the Atlantic Ocean offshore of the New York and New Jersey metropolitan area that is approximately 15,000 square nautical miles (nmi²) in area (Fig. 1). It extends 80 to 120 miles offshore from Long

Island, NY and New Jersey to the continental shelf edge. In general, water depths gradually increase toward the shelf edge reaching depths of more than 300 feet. However, the Hudson Shelf Valley, which extends from the Hudson River across the shelf, cuts as much as 120 feet below the shelf floor. The Christiaensen Basin lies at the head of the Hudson Shelf Valley. The Apex of the Bight is a roughly rectangular area of approximately 600 nmi² at the entrance to NY Harbor; it is bounded to the south by latitude 40°10'N and to the east by longitude 73°30'W. The Bight sea floor is covered by sandy deposits up to 33 feet thick. (Williams and Duane 1974; Freeland and Swift 1978)

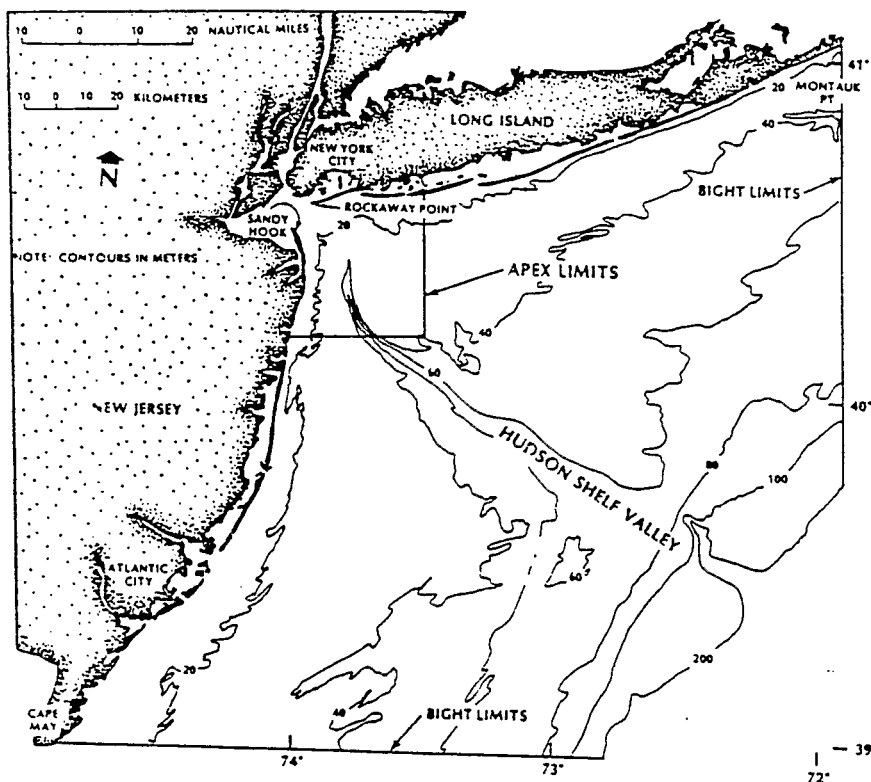


Figure 1. Location map of New York Bight and the Bight Apex. Note that the continental shelf edge is marked by the 200-meter depth contour on this map. (Adapted from EPA 1980b, Fig. 1-1.)

DISPOSAL OF WASTES AND DREDGED SEDIMENTS IN THE NEW YORK BIGHT

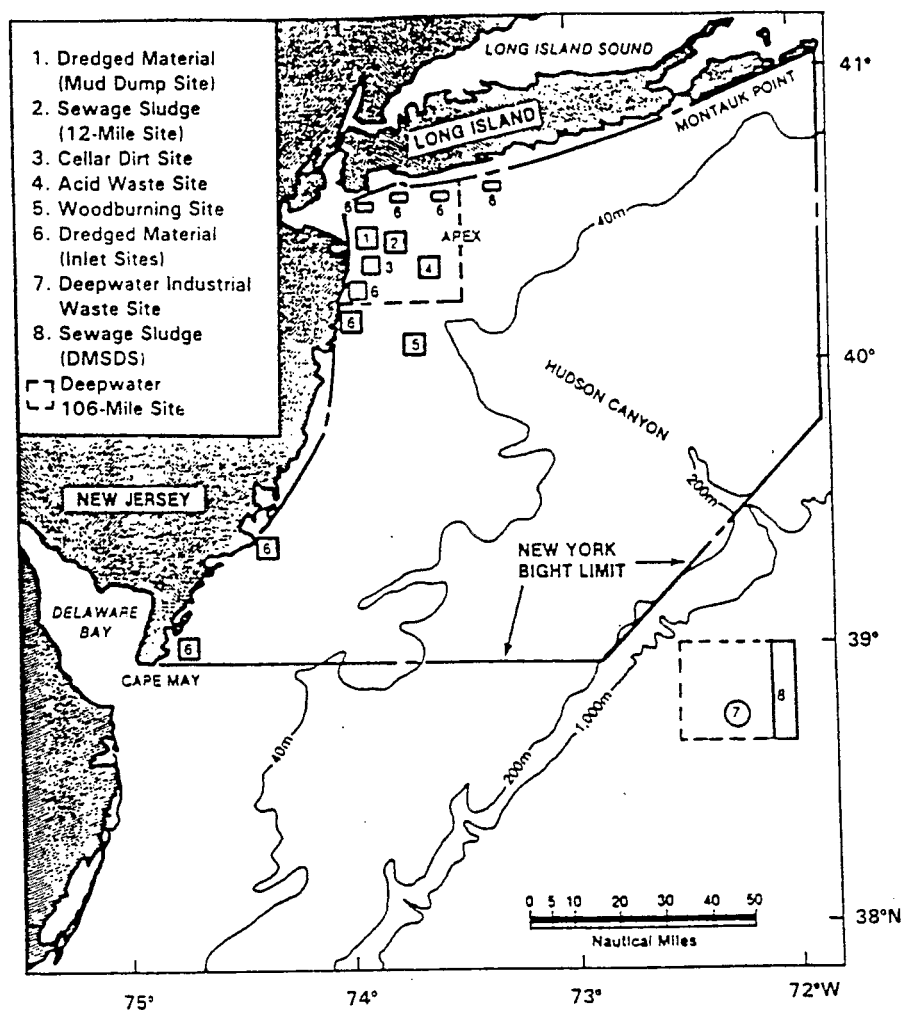


Figure 2. Location map of past and present ocean disposal sites in the NY Bight. Note that the inshore site boundaries are shown schematically. Note also that the Deepwater 106-Mile Site contains the Deepwater Industrial Waste Site and Deepwater Sludge Dump Site and it is not one of the numbered sites in the legend but is shown by a dashed line. (Adapted from EPA 1989b.)

Table 1. Locations and areas of ocean disposal sites in the New York Bight.

Rectangular Sites	Latitude Boundaries	Longitude Boundaries	Area (nmi ²)
Mud Dump Site	40°21'48" to 40°23'48"N	73°50'00" to 73°51'28"W	2.3
12-Mile Site	40°22'30" to 40°25'00"N	73°41'30" to 73°45'00"W	6.6
Acid Waste Site	40°16' to 40°20"N	73°36' to 73°40"W	12
Woodburning Site	40°00'00" to 40°04'20"N	73°38'10" to 73°41'00"W	12.5
Deepwater 106-Mile Site	38°40' to 39°00'N	72°00' to 72°30'W	500
Sewage Sludge (DMSDS)	38°40' to 39°00'N	72°00' to 72°05'W	100
Circular Sites	Center Point	Radius (nmi)	Area (nmi ²)
Cellar Dirt Site	40°23'N, 73°49'W	0.6	1.1
Industrial Waste Site	38°45'N, 72°20'W	3	28
Polygonal Sites	Center Point		Area (nmi ²)
Rockaway Inlet, NY	40°32'15"N, 73°54'30"W		0.38
East Rockaway Inlet, NY	40°34'38"N, 73°48'00"W		0.38
Jones Inlet, NY	40°34'10"N, 73°38'10"W		1.19
Fire Island Inlet, NY	40°36'41"N, 73°22'35"W		1.09
Shark River Inlet, NJ	40°12'12"N, 73°59'39"W		0.6
Manasquan Inlet, NJ	40°06'30"N, 74°01'33"W		0.11
Absecon Inlet, NJ	39°21'13"N, 74°23'47"W		0.28
Cold Spring Inlet, NJ	38°55'37"N, 74°53'14"W		0.13

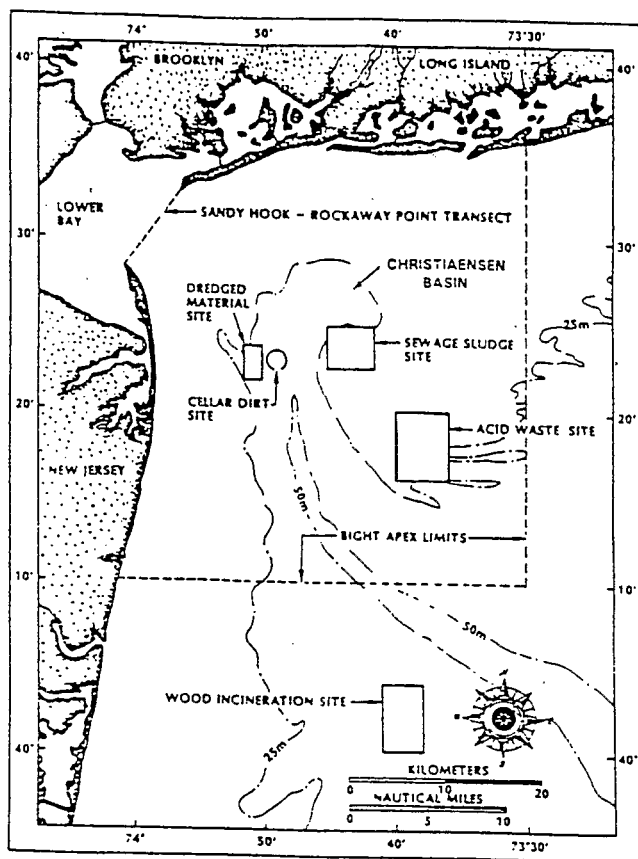


Figure 3. Location map of past and present ocean disposal sites in the Bight Apex. (Adapted from EPA 1980b, Fig. 3-1.)

Historically, a great variety of wastes have been disposed in the Bight. Descriptions of prior ocean disposal activities dating back to the late 1800s may be found in other sources (Gross 1976, Mueller and Anderson 1978, and Squires 1983). Although the ocean disposal of dredged material has been regulated by the USACE since the passage of the Rivers and Harbors Act of 1899, the federal ocean disposal program governing a much wider variety of materials was not established until the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972. Under the federal program, six types of material have been disposed in the Bight: acid waste, cellar dirt, woodburning at sea, industrial waste, sewage sludge, and dredged material. Dredged material, consisting of sediment deposited *naturally* in navigation channels, is the only one of these materials that is not anthropogenically generated.

This paper first describes the history of each of the programs, including a description of (a) the types of material disposed; (b) the disposal site locations; (c) the history of use and regulation of the disposal sites; (d) the quantities of material disposed; and (e) the current program status. Second, a more detailed description is given for dredged material, the one remaining ocean disposal program. Finally, the historical trends for ocean disposal are discussed. These include increases in scientific research, public involvement, government oversight, and

the use of non-ocean alternatives, as well as decreases in ocean disposal activities.

Figures and tables show the locations of the Bight and the historical disposal sites, annual disposal quantities, and the history of use and regulation of disposal sites. Note that although the annual dredged material disposal volumes come from a database that the USACE's New York District has maintained for many years, the other disposal quantity data was culled from disparate sources from EPA Region 2. They include Environmental Impact Statements (EIS), reports to Congress, published papers by contractors and EPA personnel, and unpublished internal EPA reports and fact sheets. The records are not all fully documented and data from different sources are occasionally inconsistent. As a result, these data (especially data from before the late 1980s) are presented only as the best available. The environmental impacts of disposal in the Bight are beyond the scope of this paper, but are discussed in Mayer (1982), HydroQual (1989), Munns and Rubinstein (1990), Swanson and others (1991), EPA (1990b), NOAA (1995), and EPA and others (1996).

ACID WASTE

Material.-- Waste disposed at the Acid Waste Site consisted almost entirely of liquid, highly acidic ($\text{pH} < 1$) waste generated from industries in New Jersey. For example, sulfuric acid and ferrous sulfates were generated from the processing of a titanium dioxide pigment, and hydrochloric acid and hydrofluoric acid were produced during the manufacture of refrigerants like freon.

Disposal Site.-- The Acid Waste Site was located approximately 15 nautical miles (nmi) south of Long Beach, Long Island, and approximately 15 nmi east of Long Branch, NJ. Its water depths ranged from 75 to 95 feet. (See Table 1 and Fig. 3)

Use and Regulation.-- The site was first used for the disposal of acid waste products in 1948. It received interim designation in 1973. A draft EIS associated with designation of this site for continuing use was issued in December 1979 and the final EIS in September 1980 (EPA 1980b). The final EIS found that the acid wastes (pumped out of rubber-lined barges at keel level to promote faster dilution) were neutralized by the seawater within minutes and that long-term adverse effects of past dumping had not been documented. Aesthetic effects included water discolorations (light green when ferrous sulfates were first released and rusty brown shortly thereafter when the sulfates were oxidized to ferric hydroxides). The site was officially designated as a disposal site by EPA in June 1983.

Because of the stringent permit conditions imposed by EPA, dumpers eventually withdrew their permit applications. The last one was withdrawn in 1988. In addition, the Ocean

DISPOSAL OF WASTES AND DREDGED SEDIMENTS IN THE NEW YORK BIGHT

Dumping Ban Act (ODBA) of 1988 specifically prohibited new entrants from applying for permits. As a result, there has been no further disposal at the Acid Waste Disposal Site and monitoring studies were discontinued. The Acid Waste Site was officially dedesignated in 1991.

Quantities.-- A table and histogram of the annual amounts of acid waste disposed at the site between 1973 and 1988 are shown in table 2 and figure 4. The quantities of acid waste discharged at the site generally decreased from 1,756,000 wet tons in 1981 to 47,700 wet tons in 1988, the final year of disposal. The three permittees using the Acid Waste Site in 1973 contributed to the overall decrease and some minor perturbations: (a) the major waste contributor (generally contributing >90% of the waste volume) had a strike and plant shutdown during 1976 and 1977, and ceased ocean disposal in 1983; (b) a minor contributor was required by EPA to move its disposal operations to the Deepwater 106-Mile Site in 1974; and (c) the other minor contributor shut down certain manufacturing processes between 1973 and

1978, and withdrew its permit application in 1988 (EPA 1980a and 1989b).

Current Status.-- With the ODBA and the dedesignation of the Acid Waste Site, there is and will be no disposal of acid waste in the NY Bight. Many acid byproducts are now beneficially reused as starting ingredients for other industrial processes.

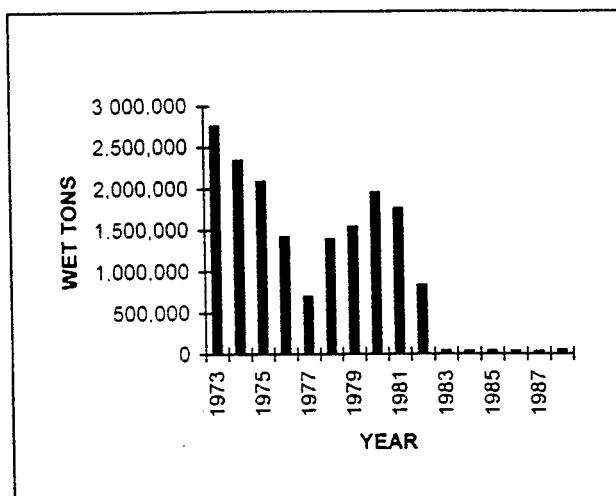


Figure 4. Histogram of annual acid waste disposal quantities, 1973-1988. Note: Quantities originally reported in "metric tons" in EPA 1980b have been converted to "tons" in this table.

Table 2. Annual acid waste disposal quantities, 1973-1988. Note: Quantities originally reported in "metric tons" in EPA been converted to "tons" in this table.

Year	Quantity (wet tons)	Reference
1973	2,756,000	EPA 1980b, p. D2
1974	2,333,000	EPA 1980b, p. D2
1975	2,079,000	EPA 1980b, p. D2
1976	1,409,000	EPA 1980b, p. D2
1977	697,000	EPA 1980b, p. D2
1978	1,386,000	EPA 1980b, p. D2
1979	1,535,000	EPA 1980b, p. D2
1980	1,947,000	Suskowski & Santaro, 1986, Table 1
1981	1,756,000	EPA 1984
1982	833,000	EPA 1984
1983	38,000	EPA 1984
1984	34,000	EPA, 1987
1985	39,000	EPA, 1988b
1986	33,800	EPA 1988b
1987	32,600	EPA 1988b
1988	47,700	EPA 1990
Total	15,009,100	
Avg/yr	938,000	

INDUSTRIAL WASTE

Material.-- Industrial waste consisted of solid, semi-solid, or liquid byproducts generated by manufacturing or processing plants, such as produced during the manufacture of paint or chemicals.

Disposal Sites.-- The Deepwater 106-Mile Site has been used for industrial and other wastes. Located about 106 nmi southeast of Ambrose light and about 126 nmi off the coast of Cape May, NJ, it covered an area of approximately 500 nm². It was just beyond the continental shelf within the influence of the Gulf Stream. Water depths ranged from 4600 to 9200 feet. A second disposal site, a circular area with a radius of 3 nmi located within the Deepwater 106-Mile Site, was known as the Deepwater Industrial Waste Disposal Site. The locations of these sites are shown in table 1 and figure 2.

Use and Regulation.-- The Deepwater 106-Mile Site was first used in 1961. Between 1961 and 1973, it was used intermittently for various wastes including munitions, radioactive materials, acids, chemical wastes, sewage sludge, and residues from sewage sludge digesters. In 1973, this site was designated as an interim site to be used primarily for industrial chemical wastes (EPA 1980).

In February 1980, a final EIS was published for the Deepwater 106-Mile Site (EPA 1980a). Because of concern

that monitoring efforts would be complicated by the mixed disposal of industrial wastes and sewage sludge, designation of two disposal sites within the Deepwater 106-Mile Site was recommended. One, restricted to disposal of industrial wastes, was known as the Deepwater Industrial Waste Disposal Site. The other site, restricted to municipal sewage sludge and known as the Deepwater Municipal Sludge Dump Site, is discussed in the sewage sludge section of this paper. The Deepwater Industrial Waste Disposal Site was designated as a permanent site in May 1984.

After the industrial waste site came under its regulation in 1973, EPA issued permits only if there was no technically feasible, economically reasonable, non-ocean disposal alternative with less adverse impact on the overall environment. As a result, the number of permits which EPA issued for ocean disposal of industrial waste declined from 66 in the 1973 to 4 in 1979 and none after 1987 (EPA 1980b). There has been no ocean disposal of industrial waste since then. The Deepwater Industrial Waste Disposal Site was formally dedesignated in February 1990, thus terminating any use of this site for ocean disposal activity.

Quantities.-- A table and histogram of the annual amounts of industrial wastes disposed at the site between 1973 and

Table 3. Annual industrial waste disposal quantities, 1973-1987. * Quantities listed are projected amounts, not reported ones. Note: Quantities originally reported in "metric tons" in EPA 1980b have been converted to "tons" in this table.

Year	Quantity (wet tons)	Reference
1973	375,000	EPA 1980b, Table 3-4
1974	491,000	EPA 1980b, Table 3-4
1975	634,000	EPA 1980b, Table 3-4
1976	412,000	EPA 1980b, Table 3-4
1977	843,000	EPA 1980b, Table 3-4
1978	877,000	EPA 1980b, Table 3-4
1979	828,000*	EPA, 1980b, Table 3-5
1980	774,000*	EPA, 1980b, Table 3-5
1981	267,000	EPA, 1984
1982	230,000	EPA, 1984
1983	245,000	EPA, 1984
1984	155,000	Hunt & others 1994, Table 1
1985	100,000	Hunt & others 1994, Table 1
1986	213,000	Hunt & others 1994, Table 1
1987	28,000	Hunt & others 1994, Table 1
Total	6,472,000	
Avg/yr	431,000	

1987 are shown in table 3 and figure 5 respectively. Although the number of permittees decreased steadily from 1973 to 1987, the quantity of industrial wastes dumped at the site increased from 375,000 wet tons in 1973 to a peak of 877,000 wet tons in 1978 before declining. These increased quantities were produced by the relocation to the site of several industrial waste generators during this period (specifically from the 12-Mile Site in 1974, the Acid Waste Site in 1975, the Delaware Bay Acid Waste Site in 1977, and Camden NJ in 1977) (EPA 1980b). After 1978, industrial waste quantities mostly decreased until 1987 when the last 28,000 wet tons were disposed.

Current Status.-- With formal closure of the site in 1990 and by mandate of the Ocean Dumping Ban Act, there is no

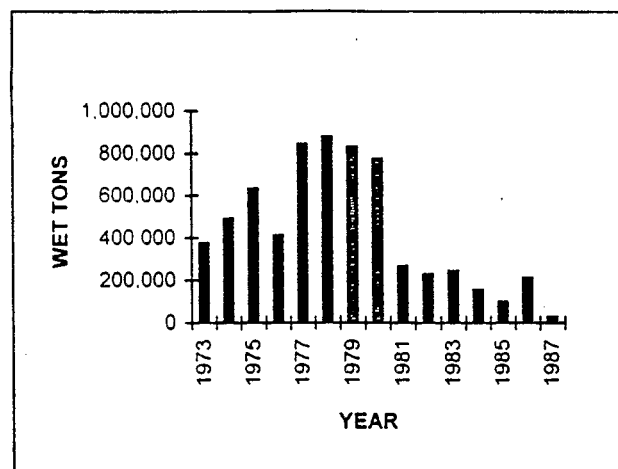


Figure 5. Histogram of annual industrial waste disposal quantities, 1973-1987.

continuing ocean disposal of industrial waste. Only land-based disposal methods may now be used for industrial waste. Some wastes have been reduced by eliminating practices or steps in the manufacturing process or by reusing the byproducts in other processes.

CELLAR DIRT

Material.-- Cellar dirt has consisted of concrete, excavation dirt, rubble, rock and other debris from construction and demolition activities.

Disposal Sites.-- The center of the Cellar Dirt Site was located approximately 6.6 nmi east of Highlands, New Jersey and 11.7 nmi south of Rockaway, Long Island, New York. It was positioned in a circle with a radius of 0.6 nmi. Water depths at the site ranged from 95 to 125 feet. (Table 1 and Fig. 2)

Use and Regulation.-- The earliest record for the ocean disposal of cellar dirt was in 1908 in an area three miles southeast of Scotland Lightship. As the area shoaled, the disposal site was moved progressively offshore into deeper water. The area eventually designated as the Cellar Dirt

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Disposal Site had been in use since 1940. Following the formation of EPA in 1970 and the subsequent enactment of permitting regulations for ocean dumping, EPA designated this site as an interim site (and began issuing permits) in 1973. Pursuant to this interim designation, EPA published a draft EIS in 1981. The final EIS (EPA 1982a) was published in 1982 and the Cellar Dirt Site was formally designated a permanent disposal site in November 1983. Because land-based alternatives had been adopted by all previous generators of cellar dirt and there was no continuing need for ocean disposal, the last permit for the Cellar Dirt Disposal Site expired in November 1989 and the site was formally dedesignated by EPA in 1994.

Quantities.-- Historically, the amount of material disposed at the Cellar Dirt Disposal Site varied from year to year because of differences in construction activity and the use made of the debris. For example, 31 million cubic yards (mcy) of material were estimated to have been excavated during the construction of the New York City subway system between 1900 and 1950, but much of this material did not end up at the Cellar Dirt Site as it was used for landfill at Governors Island and other locations (Gross

1976). A table and histogram of the annual volumes of cellar dirt disposed at the site between 1973 and 1989 are shown in table 4 and figure 6 respectively. As land-based disposal alternatives were adopted, ocean disposal of cellar dirt declined. It went from 885,000 cubic yards in 1973 to 81,000 cubic yards in 1980 and only sporadic and smaller amounts were disposed from 1981 to 1989.

Current Status.-- There are no continuing disposal programs for cellar dirt in the NY Bight. Cellar dirt that has

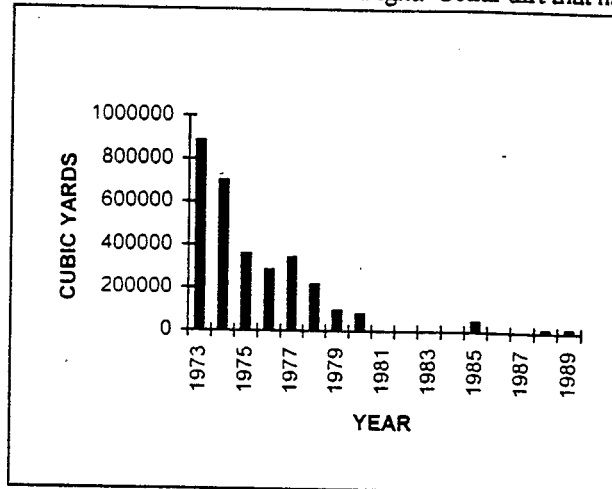


Figure 6. Histogram of annual cellar dirt disposal volumes, 1973-1989.

Table 4. Annual cellar dirt disposal volumes, 1973-1989.

Year	Volume (cubic yards)	Reference
1973	885,455	EPA 1982a, Table 3-14
1974	700,000	EPA 1982a, Table 3-14
1975	360,000	EPA 1982a, Table 3-14
1976	286,364	EPA 1982a, Table 3-14
1977	344,545	EPA 1982a, Table 3-14
1978	219,091	EPA 1982a, Table 3-14
1979	97,273	EPA 1982a, Table 3-14
1980	81,000	EPA 1982a, Table 3-14
1981	0	EPA 1988b; EPA 1984
1982	0	EPA 1988b; EPA 1984
1983	0	EPA 1988b; EPA 1984
1984	0	EPA 1988b
1985	50,000	EPA 1988b
1986	0	EPA 1988b
1987	0	EPA 1988b
1988	15,300	EPA 1988b
1989	17,450	EPA 1990
Total	3,056,478	
Avg/yr	180,000	

been determined to be suitable substrate material (e.g., concrete) is now used in artificial reefs, but most is disposed on land.

WOODBURNING AT SEA

Material.-- Wood that was incinerated on barges at sea consisted of (a) driftwood, timbers, and pilings from deteriorated waterfront structures; (b) derelict wooden hulls; and (c) similar structures from the NY-NJ Harbor region. Woodburning at sea was regarded as a form of ocean disposal because particulate matter generated by the incineration plume and the wetdown operations ultimately entered the ocean. Note that unburned wood and ashes left over from woodburning operations were not permitted to be disposed in the ocean and had to be brought back to land for subsequent burning or disposal at a landfill.

Disposal Site.-- The Woodburning Site was located approximately 17 nmi off the coast of Point Pleasant, New Jersey. Water depths averaged approximately 100 feet at the site. (See Table 1 and Fig. 3)

Use and Regulation.-- The woodburning site had been used historically by the USACE, the City of New York, and private waste transporters since the 1960s, primarily by the USACE under its New York Harbor Drift Removal Project. The New York and New Jersey Harbor area is a major port with extensive waterfront development. Because many of

the waterfront structures were old and deteriorated, wood fragments frequently entered the waterways. The USACE, having the responsibility to maintain navigable waterways, regularly removed this wood and other hazards to navigation in the Harbor. Helicopters were used to locate debris slicks, and vessels to scoop up the floating debris. In addition, the USACE demolished deteriorated structures to prevent future navigation hazards and to clean up areas for subsequent redevelopment. Most of the wood collected from this project was disposed at the woodburning site. Tugs towed the wood-filled barges 8 to 12 hours to the site. Woodburning operations at the site took 24 to 60 hours.

In the mid-1970s, following the enactment of MPRSA, EPA began issuing permits for this site and keeping records of volumes burned there. In accordance with its ocean dumping criteria, EPA did not issue permits for woodburning at sea if there was a technically feasible and economically reasonable alternative with less adverse impact to the overall environment. The woodburning site was designated as an interim site in 1977 based on its use prior to the enactment of MPRSA. Public concerns included reports of "vessel on fire," smoke plumes, floating and submerged debris, and interference with fishing and other recreational activities. Over time, permit conditions were made more stringent to address these and other concerns. Specific conditions included stanchions and chain-link fencing for containing the material on the barges, tugs following the barges to retrieve lost material, minimum 2-hour wetdown periods to extinguish all flames, shipriders for inspection, and a ban on woodburning during the summer. In addition, a comprehensive monitoring and modeling study of air and water quality was conducted. Samples were taken downwind of barges during burn events and at the burn- and wetdown sites.

In June of 1989, a draft EIS (EPA 1989a) was prepared to assist in determining whether or not an ocean woodburning site should be designated. However, WRDA of 1990 banned woodburning at sea after December 1993. Because of the time and resources needed to complete the EIS and designate the site for use for what would be a very short period of time, EPA decided not to designate the site as a permanent one and to terminate the EIS process. The remaining permit was denied in 1991 and there has been no disposal since. Because WRDA of 1992 prohibits disposal at *interim-designated* sites after January 1, 1997, the woodburning site will be effectively dedesignated at this time. Since the end of woodburning at sea, about half the driftwood and other wooden debris removed by the USACE is incinerated and the rest is landfilled.

Quantities.-- A table and histogram of the annual amounts of woodburning at sea between 1973 and 1990 are shown in table 5 and figure 7 respectively. The amounts varied from year to year depending mostly on the amount of wood collected in the USACE's shoreline demolition program.

This is because the USACE was the largest user of the woodburning site, accounting for more than 75% of the wood burned between 1973 and 1988, and because more than 90% of the USACE's woodburning was from shoreline demolition and less than 10% from driftwood collection.

Current Status.-- There is no continuing woodburning-at-sea program in the NY Bight.

SEWAGE SLUDGE

Material.-- Municipal sewage sludge consisted of the solid, semi-solid, or liquid residues generated during the treatment of domestic sewage in a wastewater treatment facility. The sewage sludge disposed was mostly water; it consisted of only about 5% solids on a dry weight basis.

Disposal Sites.-- Two sites have been used for the ocean disposal of municipal sewage sludge in the New York Bight. One site, located on the continental shelf approximately 12 miles outside of New York Harbor and

Table 5. Annual woodburning-at-sea disposal quantities, 1973-1990.

Year	Quantity (tons)	Reference
1973	10,800	EPA 1989, Table 1-2
1974	15,800	EPA 1989, Table 1-2
1975	6,200	EPA 1989, Table 1-2
1976	8,700	EPA 1989, Table 1-2
1977	15,100	EPA 1989, Table 1-2
1978	18,000	EPA 1989, Table 1-2
1979	45,000	EPA 1989, Table 1-2
1980	10,500	EPA 1989, Table 1-2
1981	16,100	EPA 1989, Table 1-2
1982	14,100	EPA 1989, Table 1-2
1983	31,200	EPA 1989, Table 1-2
1984	54,533	EPA 1989, Table 1-2
1985	47,385	EPA 1989, Table 1-2
1986	44,483	EPA 1989, Table 1-2
1987	35,277	EPA 1989, Table 1-2
1988	32,167	EPA 1989, Table 1-2
1989	27,204	Battelle 1990
1990	12,120	Battelle 1990
Total	444,669	
Avg/yr	25,000	

DISPOSAL OF WASTES AND DREDGED SEDIMENTS IN THE NEW YORK BIGHT

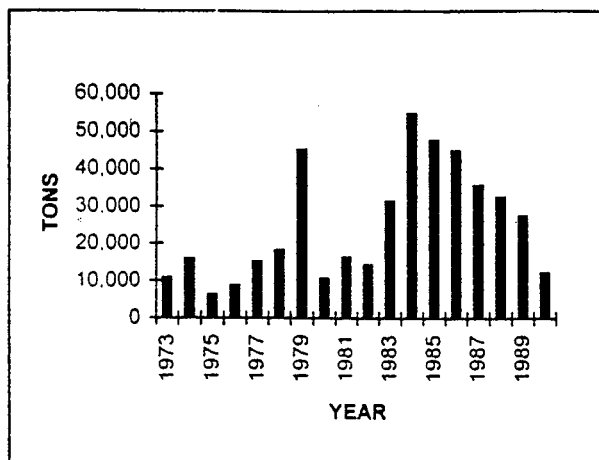


Figure 7. Histogram of annual woodburning-at-sea disposal quantities, 1973-1990.

commonly known as the 12-Mile Site, was used between 1924 and 1987. It was located 10.3 nmi east of Highlands, NJ and 9.9 nmi south of Long Beach, NY. Water depths were approximately 88 feet. (See Table 1 and Fig. 3)

The other site, officially known as the Deepwater Municipal Sludge Dump Site (DMSDS), was used from 1986 to 1992. The DMSDS was located *within* the previously interim-designated Deepwater 106-Mile Site and has also been referred to as the 106-Mile Site. The DMSDS was located off the continental shelf approximately 120 nmi southeast of Ambrose Light and 115 nmi east of Atlantic City, NJ, the nearest coastline. It occupied an area of 100 nmi² at the eastern edge of the Deepwater 106-Mile Site. Its water depths ranged from approximately 7400 to 9000 feet. (See Table 1 and Fig. 2)

Use and Regulation.-- The 12-Mile Site was first used for the disposal of sewage sludge in 1924. New York City and later additional communities in the New York and New Jersey area used the site to dispose of their municipal sludge. Following the enactment of MPRSA, EPA designated the site as an interim disposal site in 1973. An EIS for the 12-Mile Site was published in 1978 (EPA 1978). The 12-Mile Site was officially designated in May 1979, but it was stipulated that this designation would expire on December 31, 1981. In the meantime, EPA would determine whether or not to redesignate the site when its designation expired. To this end, EPA conducted monitoring studies on the environmental impacts of sludge disposal at the 12-Mile Site and decided not to redesignate. However, sludge dumpers brought a law suit against EPA in 1981 and were allowed to keep dumping at the 12-Mile Site under consent decrees until an alternative disposal option could be identified.

Meanwhile, EPA evaluated alternative ocean disposal sites. In addition to the 12-Mile Site studies, EPA had previously conducted monitoring studies at the Deepwater 106-Mile Site. These studies showed that in the deeper waters off the

continental shelf, wastes were rapidly diluted and then widely dispersed, so that water quality was only temporarily disturbed. Based on the results of these studies, EPA decided to designate a site in the deeper waters found at the Deepwater 106-Mile Site. An EIS on the Deepwater 106-Mile Site was published in 1980 (EPA, 1980a) and a new sewage sludge site (DMSDS) within the Deepwater 106-Mile Site was designated on May 4, 1984. The DMSDS' long rectangular area allowed vessels to discharge sludge over the length of the site and obtain greater dispersal. Discharge of the sludge from the vessel's wake and its descent through the water column resulted in both its dilution and dispersal.

Beginning in 1986, EPA required sludge dumpers to start transferring the ocean disposal of sewage sludge from the 12-Mile Site to the DMSDS. Use of the 12-Mile Site was phased out and all disposal transferred to the DMSDS by the end of 1987. The 12-Mile Site was formally dedesignated in February 1990. The effects of ending sewage sludge disposal at the 12-Mile Site were evaluated and presented in a symposium in 1991 (NOAA 1995).

In response to public concern over the washup of medical wastes and other debris in the NY-NJ area shores in 1987 and 1988, Congress passed the Ocean Dumping Ban Act (ODBA) in 1988. ODBA prohibited the disposal of sewage sludge in ocean waters. In accord with this act, EPA issued ocean dumping permits to the nine remaining New York and New Jersey sewerage authorities in August of 1989 and entered into consent decrees and enforcement agreements with them that specified dates to end disposal operations as well as stiff penalties if these dates were not met. These actions led to the phase out of all ocean disposal of municipal sewage sludge in the Bight by June 1992.

Quantities.-- A table and histogram of the annual amounts of sewage sludge between 1972 and 1992 are shown in table 6 and figure 8 respectively. (Note that these quantities are given in wet weight and would be much less if given on a dry weight basis.) Although the number of municipal sludge dumpers gradually decreased after the passage of MPRSA, the annual amount of sludge dumped continued to increase (from 4.6 million wet tons in 1973 to 11.0 million wet tons in 1990). This increase resulted primarily from the upgrading of sewage treatment plants and the resultant increase in municipal sludge production. After 1990, the amounts of sewage sludge declined (to 7 million wet tons in 1991 and 2 million wet tons in 1992) as the remaining sewerage authorities ended their ocean disposal of sewage sludge.

Current Status.-- With formal closure of the site in 1992 and by mandate of the ODBA, there is no continuing ocean disposal of municipal sewage sludge in the NY Bight.

Non-Ocean Alternatives for Sewage Sludge.-- Since June of

Table 6. Annual sewage sludge disposal quantities, 1972-1992.

Year	12-Mile Site (wet tons)	106-Mile Site (wet tons)	Both sites (wet tons)	Reference
1972	4 900.000		4 900.000	Csulak & others 1986
1973	4.500.000		4.500.000	Csulak & others 1986
1974	4 200.000		4 200.000	Csulak & others 1986
1975	4 300.000		4 300.000	Csulak & others 1986
1976	4 400.000		4 400.000	Csulak & others 1986
1977	4 500.000		4 500.000	Csulak & others 1986
1978	4 900.000		4 900.000	Csulak & others 1986
1979	5 900.000		5.900.000	Csulak & others 1986
1980	7 200.000		7 200.000	Csulak & others 1986
1981	6 700.000		6.700.000	Csulak & others 1986
1982	7 600.000		7 600.000	Csulak & others 1986
1983	8 300.000		8 300.000	Csulak & others 1986
1984	6 800.000		6.800.000	Csulak & others 1986
1985	7.200.000		7.200.000	Csulak & others 1986
1986	6.639.000	1 561.000	8.200.000	EPA 1991
1987	3.978.000	4.447.000	8.425.000	EPA 1991
1988		8.744.000	8.744.000	EPA 1991
1989		9 557.000	9.557.000	Battelle 1990
1990		11.000.000	11.000.000	Battelle 1990
1991		6.576.000	6.576.000	Ruhsam 1992
1992		2.000.000	2.000.000	Hunt & others 1994
Total	92.017.000	43.885.000	135.902.000	
Av/yr			6.795.000	

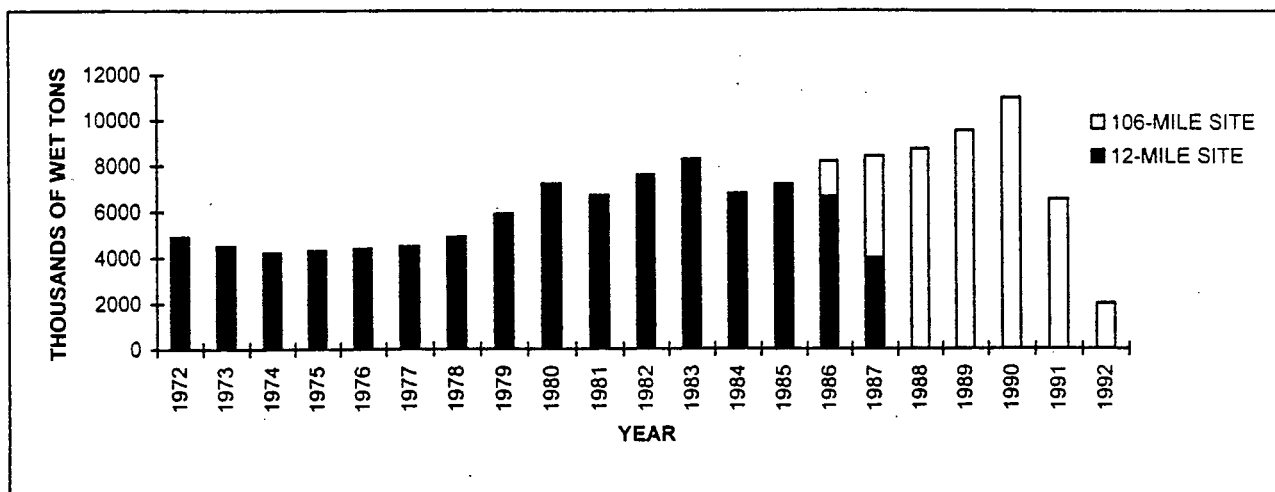


Figure 8. Histogram of annual sewage sludge disposal quantities, 1972-1992.

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1992, the sewage sludge generated by the New York and New Jersey sewerage authorities has no longer been disposed in the Bight, but has been used or disposed on land in four main ways: land application, incineration, landfilling, and disposal out-of-state. These non-ocean alternatives and their uses are described below.

Land application is the (a) the spraying or spreading of sewage sludge onto the land surface, (b) the injection of it below the land surface, or (c) its incorporation into the soil so that the sewage sludge can either condition the soil or fertilize crops or vegetation grown in the soil (40 Code of Federal Register (CFR) Part 503). Land application includes land reclamation and soil enhancement. It is considered a beneficial use which can be used on many types of land, including agricultural land, forests, reclaimed land, lawns and home gardens, and public contact sites. Public contact sites include parks, plant nurseries, and highway median strips.

Incineration is the combustion of organic matter and inorganic matter in sewage sludge by high temperatures in an inclosed device (40 CFR Part 503). Landfilling involves the co-disposal of sewage sludge with municipal solid waste or the use of sewage sludge as landfill cover. For out-of-state disposal, sewage sludge is transported, usually by rail, to other states, such as Pennsylvania, Ohio, Connecticut, Texas, West Virginia, and Colorado. Disposal in these other states consists mainly of landfilling and land application.

The use of each of these non-ocean alternatives for managing sewage sludge from New York and New Jersey has been estimated by EPA's Region 2. Based on annual sludge reports submitted from major sewage treatment plants (197 in New York and 97 in New Jersey), Region 2 estimates a dry weight total of 577,000 tons of sewage sludge was generated in New York and New Jersey in 1994. The breakdown of the disposal options used is shown in table 7 and figure 9. Approximately one-third was sent out-of-state, another third applied to the land, a fifth incinerated, and an eighth landfilled. All the landfilling was done in New York, as New Jersey has banned landfilling of sludge. (EPA 1996)

(Note that the quantities of sewage sludge are given in dry weight tons and that these are not directly comparable or convertible to the quantities of ocean-disposed sewage sludge that are given in wet weight. This is because the range of solids content varies for treatment facilities from a couple of percent to as much as 28%.)

EPA, NY and NJ all encourage the beneficial uses of sewage sludge. EPA's policy on municipal sludge management states that EPA "will actively promote those municipal sludge management practices that provide for the beneficial use of sludge while maintaining or improving environmen-

tal quality and protecting public health" (49 Federal Register 24358, June 1984). As a result of these policies, land application is the use most expected to increase in the future.

Table 7. Beneficial and other sludge use quantities for New York and New Jersey in 1994.

	NY	NJ	NY + NJ
Land application	31%	31%	31%
Incineration	23%	21%	22%
Landfill	20%	0%	12%
Out-of-State	25%	47%	34%
Total dry weight (tons)	341,000	236,000	577,000

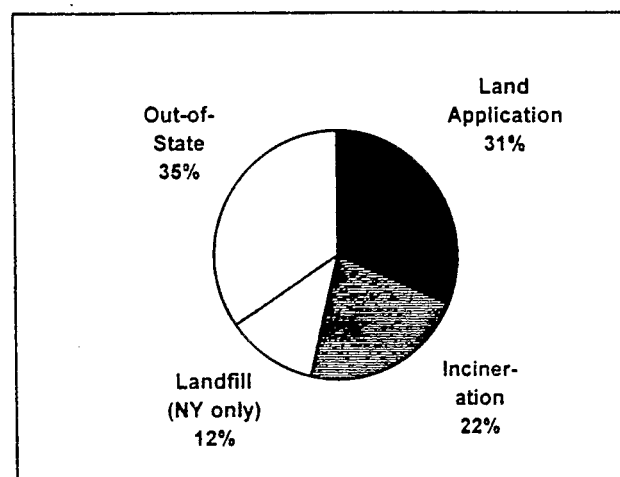


Figure 9. Pie-chart of beneficial and other sludge use quantities for New York and New Jersey in 1994.

DREDGED MATERIAL

As indicated above, dredged material consists of the sediments deposited *naturally* in waterways and so in this sense it is not an anthropogenically generated "waste" product (see Tavoraro and Freeman 1990 for a discussion on this). Disposal of dredged material in the Bight occurs at both the Mud Dump Site and at eight inlet sites.

Mud Dump Site

Material.-- Sediments are dredged from the New York Harbor region to assure that the navigation channels and berths can accommodate the cargo-, container-, and passenger ships coming into the Port. The USACE's New York District is responsible for maintaining and improving all waterways within the Port. Most federal dredging projects are for maintaining water depths at previously authorized levels, but some are for deepening waterways to newly authorized depths. In addition, privately owned marine cargo terminals and marinas are also maintained by dredging.

The sediments dredged from the Harbor have been predominantly fine grained. Based on data from 1980 to 1990, an average of approximately 33% of the material disposed in the ocean was sand, 44% was silt, and 23% was clay (USACE and EPA 1994).

Before dredged material can be disposed in the ocean, it must undergo rigorous physical, chemical and biological testing to ensure that the material will not unacceptably degrade the ocean environment. Sediments and water are sampled from the proposed dredging area and are subjected to a tiered-testing scheme. If the material consists of more than 90% sand, no further testing is required as the material is considered essentially clean. This is because many pollutants are hydrophobic and as a result tend to associate with material having a high organic content. Such material is fine grained and generally settles out of suspension with other fine-grained material (i.e., clays and silts). If the material is found to be less than 90% sand, then additional testing is required. Chemical tests include analysis for specific pollutants in the bulk sediment and the elutriate. Biological tests assess the bioaccumulation of contaminants in marine organisms and their mortality when exposed to the proposed dredged material. These tests are described in 1977 and 1991 manuals commonly known as the old and new Green Books (EPA and USACE 1977 and 1991) and a revised regional guidance document for implementing the new Green Book (EPA and USACE 1992).

Based on these tests, the sediments pass or fail the ocean disposal criteria and are classified by EPA Region 2 and the USACE New York District into one of three categories.

- Category 1: Sediments which meet ocean disposal criteria; they are acceptable for "unrestricted" ocean disposal.
- Category 2: Sediments which meet ocean disposal criteria. To protect against the potential for bioaccumulation, appropriate management techniques (such as capping with a layer of clean material) are normally required. This is referred to as "restricted" ocean disposal.
- Category 3: Sediments which do not meet ocean disposal criteria; even with the application of management techniques they are not acceptable for ocean disposal.

In the past (before the implementation of more stringent tests in 1992), almost all of the material proposed for dredging was acceptable for ocean disposal. Data from 1980-1989 show that 93% of the material was classified as Category 1, 6.7% as Category 2, and 0.3% as Category 3 (USACE and EPA 1994).

Disposal Site.-- The Mud Dump Site (named after the mostly fine-grained material disposed at the site) is located approximately 5 nmi off the coast of Highlands, NJ. Water

depths ranging from 60 to 90 feet. (See Table 1 and Fig. 3)

Use and Regulation.-- Disposal sites for dredged material were moved farther offshore several times before becoming established in the Mud Dump Site in 1914. (A map showing these areas is shown in figure 10.) The moves were necessitated because disposed material created shoals that were hazardous to navigation. The Mud Dump was designated as an interim site in 1973, an EIS was prepared in 1982 (EPA 1982b), and the site was formally designated in 1984. Disposal of dredged material was typically from a split-hull barge towed to the site by a tug. Strategies used to isolate and contain material include slowing down the tugs during disposal for pinpoint dumping, disposal in deeper areas where material is less apt to be resuspended, and capping with clean material.

Volumes.-- The annual volumes disposed at the Mud Dump have averaged almost 6 mcy, an amount that generally exceeds the volume of material disposed at any of the other disposal sites in the Bight. Table 8 and Figure 11 show the annual volumes of dredged material disposed in the Bight between 1976 and 1995, including the breakdown of federal navigation projects (maintenance and deepening) and private maintenance projects. Approximately two-thirds of the material dredged from the Harbor region between 1976 and 1995 were federally funded projects undertaken by the New York District; the other projects were private. The annual volumes disposed vary widely. This is partly due to the additional volumes excavated for the Kill Van Kull deepening project. When the Kill Van Kull (and parts of Newark Bay) were deepened to 45 feet between 1987 and 1995, approximately 18.4 mcy of sediment and rock were removed and approximately 7.4 mcy of this volume were removed in 1989 alone. Note that 3 mcy of excavated rock from this deepening project were beneficially used at an artificial reef off Sandy Hook.

Current Status.-- The ocean disposal of dredged material from the Harbor region is a continuing program that is in crisis. The current program is discussed in a separate section.

Inlet Sites

Material.-- Material deposited by longshore currents on the updrift side of an inlet is dredged to keep the inlet open for navigation purposes. The majority of this material is clean sand suitable for beneficial use as beach nourishment.

Disposal Sites.-- There are eight inlet sites for dredged material disposal serving specific inlets in the NY Bight. Four are along the Long Island coast of New York (Rockaway, East Rockaway, Jones, and Fire Island Inlet disposal sites) and four along the New Jersey coast (Shark River, Absecon, Manasquan, and Cold Spring Inlet disposal sites). These disposal sites are mostly on the

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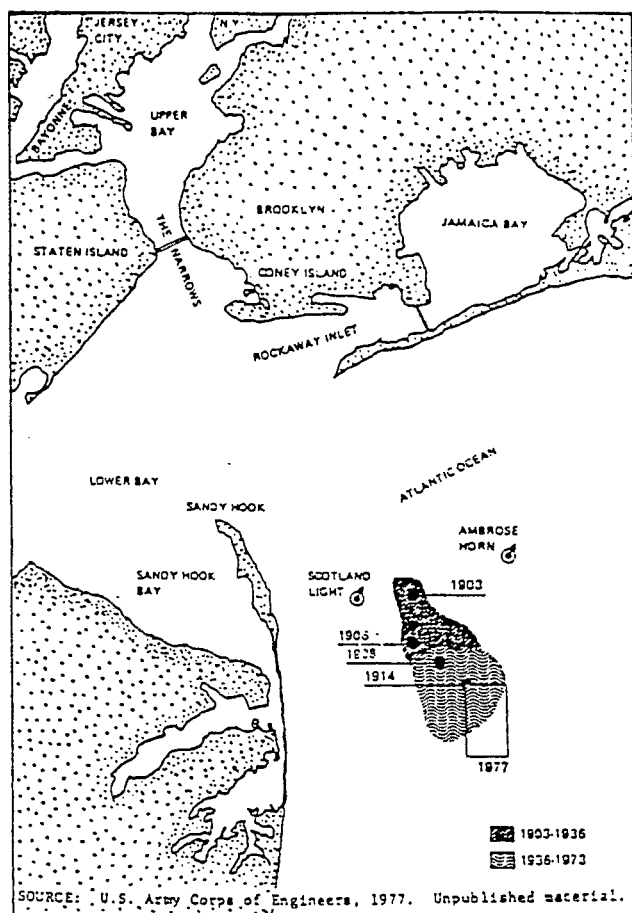


Figure 10. Map showing the historical disposal of dredged material.

downdrift, sediment-starved sides of the inlet. (See Table 1 and Fig. 2)

Use and Regulation.-- The history of dredged material disposal at the eight inlet sites is quite variable. Most of the material dredged from the inlets has been deposited along nearby beaches because the clean and predominantly sandy character of the material makes it suitable for beach nourishment. The Cold Spring Inlet disposal site was last used in 1987, the Rockaway and East Rockaway Inlet sites in 1979, and the Manasquan, Absecon, and Jones Inlet sites in 1978. The remaining two dredged material disposal sites, at Fire Island and Shark River Inlets, have not received any material in recent years. EPA continues to encourage disposal of inlet material for beachfill whenever feasible. A final EIS was published in 1988 (EPA 1988a) and the inlet sites were officially designated in 1990.

Quantities.-- Only small amounts are disposed sporadically at these sites as most sand dredged from these inlets is used beneficially for beach nourishment.

CURRENT DREDGED MATERIAL PROGRAM

Dredging Problem.-- The Port of New York and New Jersey has historically been one of this nation's leading ports. It

contains approximately 40 federally maintained waterways, 1200 waterfront facilities, 235 deep-draft terminals, and more than 1 million linear feet of berthage. Historically, the Port handles more general and containerized cargo than any other east coast port in the U.S. It presently generates 166,000 jobs, 19 billion dollars in annual sales, and 6 million dollars in wages each year. Modern deep-draft vessels vital to the economic health of the region require water depths of approximately 45 to 50 feet.

New York Harbor is not naturally deep and rivers continuously deposit sediment into it. Some of the Harbor's shipping routes are in areas where the natural water depth is 19 feet or less. To keep its channels and berths deep enough to accommodate deep-draft vessels, large volumes of sediment must be periodically removed by dredging. In the past, an average of approximately 6 million cubic yards has dredged annually to maintain navigation in the Harbor. (This amount would be enough to fill almost three World Trade Center towers each year!)

Dredging helps to solve navigation problems, but also creates problems of dredging and disposing of the material in an environmentally sound and cost-effective manner. These problems, aggravated by being in such an urban and industrial region, are listed below.

- Some of the predominantly fine-grained Harbor sediments are contaminated with elevated levels of pollutants from a variety of sources which contain dissolved and particle-associated contaminants that eventually settle out into the sediments. Pollutant sources include municipal discharges, stormwater runoff, combined sewer overflows, industrial discharges, chemical and oil spills, atmospheric deposition, and landfill leachate. Pollutants found in Harbor sediments include heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides and dioxins. While concentrations in dredged material are typically much lower than hazardous waste levels, pollutant concentrations in Harbor sediments have been found to be among the highest of estuaries in the nation (NOAA 1991; Squibb and others 1991). Such pollutants pose threats to human health and wildlife through bioaccumulation within marine organisms and biomagnification up the food chain.

- The Mud Dump Site is nearly full. In 1984, this site was designated for an indefinite period of time and its capacity was set at 100 mcy of material. This limit was based upon navigational concerns associated with shoaling that would result from disposing the dredged material. Since the site was designated, approximately 68 mcy of material have been disposed. For a site, such as the Mud Dump, in which disposed material is to be contained at the site, the water depth of the disposal areas is an important factor in determining the site's capacity. This is because sediment resuspension (which may occur during large storm events

Table 8. Annual dredged material disposal volumes, 1976-1995, including the breakdown of federal (maintenance and deepening) projects and private (maintenance) projects. Source: USACE, New York District, 1996.

Year	Federal Maintenance (cubic yards)	Federal Deepening (cubic yards)	Private Maintenance (cubic yards)	Total (cubic yards)
1976	10,358,895	0	1,253,083	11,611,978
1977	4,516,349	0	776,969	5,293,318
1978	5,736,442	0	2,214,045	7,950,487
1979	6,058,124	0	1,146,400	7,204,524
1980	2,551,702	0	1,337,460	3,889,162
1981	1,095,109	0	1,236,000	2,331,109
1982	2,959,622	0	1,405,410	4,365,032
1983	2,951,500	0	1,211,342	4,162,842
1984	3,851,022	0	3,540,100	7,391,122
1985	4,605,709	0	997,500	5,603,209
1986	1,964,647	0	2,135,071	4,099,718
1987	2,056,199	1,834,880	2,464,251	6,355,330
1988	1,094,769	3,638,555	1,544,263	6,277,587
1989	1,715,082	7,393,961	6,092,163	15,201,206
1990	2,110,246	1,220,900	1,282,971	4,614,117
1991	2,293,700	207,650	653,858	3,155,208
1992	2,769,739	719,700	677,012	4,166,451
1993	1,510,829	688,200	3,133,015	5,332,044
1994	1,116,650	1,725,250	1,388,340	4,230,240
1995	73,507	1,001,970	874,411	1,949,888
Total	61,389,842	18,431,066	35,363,664	115,184,572
Avg/yr	3,069,000 (53%)	922,000 (16%)	1,768,000 (31%)	5,759,000 (100%)

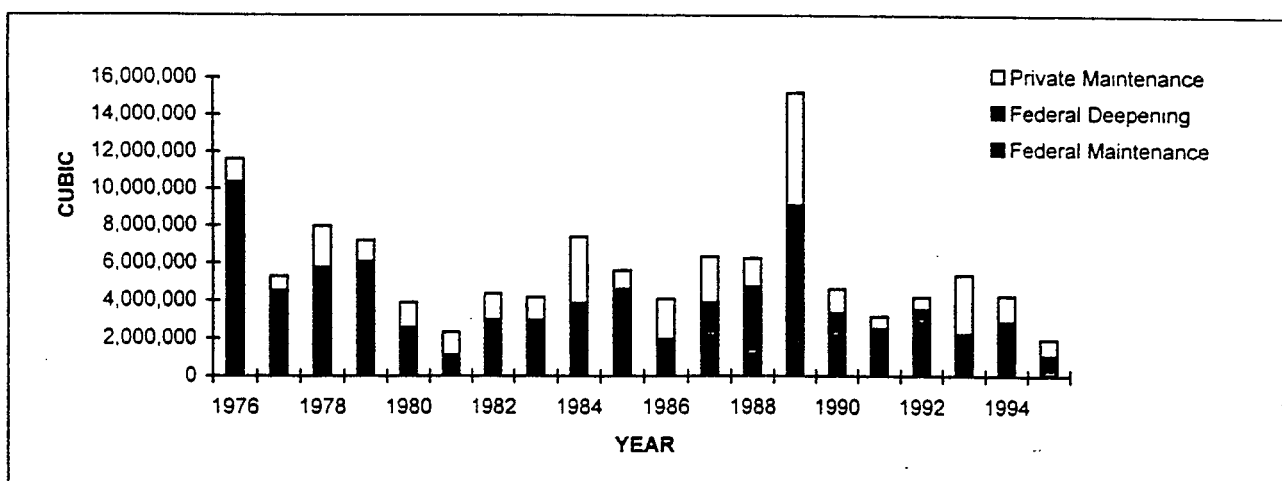


Figure 11. Histogram of annual dredged material disposal volumes, 1976-1995, including the breakdown of federal (maintenance and deepening) projects and private (maintenance) projects.

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when bottom currents are intensified) tends to decrease at greater depths. To minimize the adverse environmental impacts from sediment resuspension, Category 2 material is required to be placed at deeper depths than Category 1 material. Thus, there is a difference in capacity for Category 1 and 2 materials. Currently, the Mud Dump has practically reached its capacity for Category 2 material and its capacity for Category 1 material will last for only several more years.

- The land in and around New York Harbor is intensely developed, so limited land is available for interim or long-term disposal sites. In addition, the cost for acquiring this land is very high.

- The implementation of new more stringent testing criteria for ocean disposal makes material much less likely to pass ocean disposal criteria. With so much more material expected to be unacceptable for ocean disposal (i.e., Category 3 material), there is a great need to identify and implement alternatives to ocean disposal. In addition, the new testing protocols may increase the quantities of Category 2 material and, as noted above, the capacity for Category 2 material at the Mud Dump is already very limited.

- Public concern and controversy surround the ocean disposal of dredged material, especially material containing low levels of dioxin (2,3,7,8-tetrachlorodibenzo-*p*-dioxin).

These problems have precipitated the present crisis. Because of the different characteristics and volumes of dredged material, there can be no one single solution for these problems. Ongoing efforts to resolve these problems are described below.

HEP.-- The NY-NJ Harbor Estuary Program (HEP) and the New York Bight Restoration Plan (NYBRP) were established to preserve and restore marine resources of the Harbor and the Bight. The combined programs have set up work group subcommittees on biomonitoring, floatable marine debris, habitat, nutrients, pathogens, and toxic chemicals. (See EPA and others 1990, EPA 1993, and EPA and others 1996)

Dredged Material Management Forum.-- One of the steps taken to address the dredged material management problems in the NY/NJ Harbor was the establishment of a Dredged Material Management Forum. This forum was convened in June 1993 under the sponsorship of EPA, the USACE, and the states of New York and New Jersey. The Forum brought together a wide spectrum of governmental, environmental, commercial, and public interest groups concerned with issues associated with the dredging and disposal of sediments from the Harbor.

The Forum was incorporated into the HEP structure in 1995. It developed a Comprehensive Conservation and

Management Plan (EPA and others 1996) with a section on dredged material management in March 1996. The plan includes the following steps:

- control continuing inputs of contaminants;
- characterize, categorize, and quantify material to be dredged;
- improve dredging, transport, and disposal operations;
- identify, evaluate, and select disposal- and decontamination alternatives;
- develop plans for closure of the Mud Dump Site; and
- develop a future dredged material management structure.

Estimates of Future Dredging Needs.-- As part of the effort to "characterize, categorize, and quantify material to be dredged," the Port Authority of New York and New Jersey conducted a survey estimating the future dredging needs for the Harbor. Specifically, it estimated annual volumes of material needing to be dredged in the next five years, and classified the material according to expected results under the newer, more stringent testing protocols for ocean disposal. The survey included the USACE, past applicants for dredging permits, and others wanting to dredge in the Harbor. The USACE estimated, based on past dredging cycles, the volumes that would need to be dredged to maintain the federal navigation channels. Volumes for deepening were not included in the estimates. The volumes estimated were of the "in-place" sediments in the channels or berths, not the bulked mean volume of ocean disposal barges. The categories of the dredged material were determined for a site either from testing already done under the new criteria, or if not already tested, from estimates by waterway. For instance, it was assumed that waterways such as the Arthur Kill and the Kill Van Kull would be classified as Category 3 when tested. For Category 2 material, no capping volumes were included and these volumes can be considerable. In the past, the ratio of dredged project material to cap material volume has been as much as 1:5.

The results of this periodically updated study have been compiled in a database known as *Mud 1*. The March 1996 data are displayed in table 9 and figure 12. The projected maintenance disposal volumes for 1996-2000 average 4.1 mcy per year. Of this material, 46% is estimated to be classified as Category 1, 14% as Category 2, and 39% as Category 3. As can be seen in figure 13, more than 99% of the material proposed for ocean disposal was classified as suitable for unrestricted ocean disposal under the old tests (USACE and EPA 1994), whereas only about 60% is projected under the newer tests (Port Authority 1996).

Expansion of the Mud Dump Site.-- Because the Mud Dump Site is nearing its capacity, consideration is being given to expanding this site. EPA is therefore preparing a supplemental EIS. A draft is expected by the end of 1996. Expansion of the Mud Dump Site is also seen as an opportunity to restore areas that have been contaminated by

Table 9. Projected annual dredged material volumes, 1996-2000. Source: Dredging Database System (Mud 1) of the Port Authority of NY and NJ, March 1996.

Year:	1996	1997	1998	1999	2000	Average/yr
Category 1	1,891,200	1,850,400	4,469,000	454,000	878,100	1,908,540 (46.3%)
Category 2	283,000	1,425,500	437,500	581,500	257,500	597,000 (14.5%)
Category 3	2,469,000	1,440,100	2,020,700	1,064,300	1,088,500	1,616,520 (39.2%)
Cat 1+2+3	4,643,200	4,716,000	6,927,200	2,099,800	2,224,100	4,122,360 (100%)

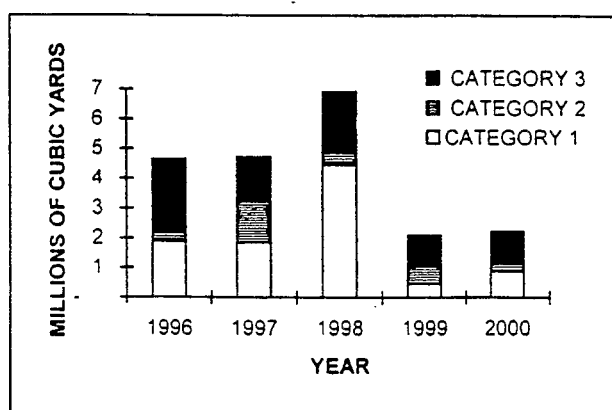


Figure 12. Histogram of projected annual dredged material volumes, 1996-2000.

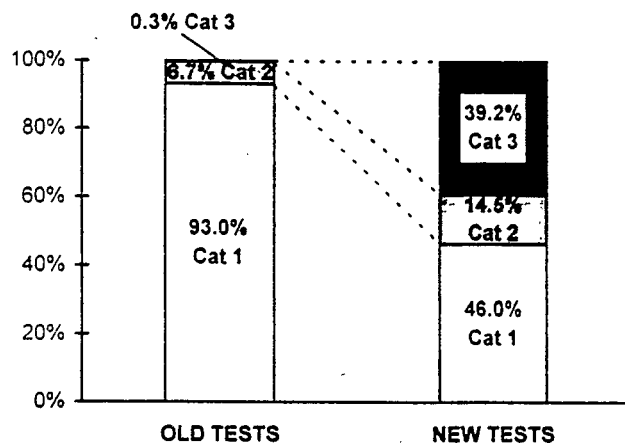


Figure 13. Comparison of percentage of Category 1, 2, and 3 dredged material before (1980-1989) and after (projected for 1996-2000) implementation of 1992 testing protocols.

the historic disposal of dredged material in the Bight Apex (EPA and others, 1996).

Site Management and Monitoring Plans (SMMPs).-- The Water Resources Development Act (WRDA) of 1992 requires all Ocean Disposal Sites to have an approved Site Management and Monitoring Plan (SMMP) for all dredged material ocean disposal sites by January 1997. In addition, it requires that all SMMPs be publicly reviewed. In accordance with this Act, SMMPs are being prepared for the present Mud Dump Site and the planned expanded one,

as well as a generic one for the eight inlet sites. The plan for the Expanded Mud Dump Site will be prepared as part of the site designation process.

DMMP.-- The USACE is developing a NY Harbor Dredged Material Management Plan (DMMP) which includes mid- and long-term disposal alternatives. Alternatives include ocean disposal, subaqueous pit containment facilities, harbor and ocean containment islands, upland disposal, decontamination technologies, and beneficial uses. (USACE, 1995)

Sediment Decontamination Program.-- One of the efforts to address the dredged material problem involves the treatment of contaminated dredged material. By reducing, separating, immobilizing, or detoxifying pollutants associated with some dredged material, this material may be rendered suitable for ocean disposal, upland disposal, or beneficial use. Under the Water Resources Development Acts of 1990 and 1992, the New York District (NYD) of the USACE and Region 2 of EPA are evaluating and demonstrating the technical and economic feasibility of technologies for treating contaminated dredged material from the NY/NJ Harbor area (Stern and others 1994). Technical assistance is being provided by the Department of Energy's Brookhaven National Laboratory (BNL), the U.S. Army Waterways Experiment Station (WES), and four regional universities (NJ Institute of Technology, Rensselaer Polytechnic Institute, Rutgers University and Stevens Institute of Technology). A public outreach program seeks to provide the public with the best available information on the various technologies as well as with opportunities to participate in the evaluation and siting process. The ultimate goal of the program is to determine which technologies are suitable for inclusion in a full-scale treatment system that is environmentally protective and cost-effective. The following list describes completed and ongoing work efforts from this program.

- An international literature survey of existing technologies for contaminated dredged material was prepared (Malcolm Pirnie 1995).
- Lab-scale treatments of incineration, thermal reduction, base-catalyzed decomposition, and chemical solvent

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extraction were conducted (Tetra Tech, Inc. and Averett 1994).

- Bench-scale tests of base-catalyzed decomposition and a process design study for full scale were also conducted (Battelle 1994 and 1995).
- Vendors were selected through a request-for-proposal process and they performed 10 bench-scale demonstrations of various technologies including thermal desorption and destruction, chemical treatments, solidification and stabilization, solvent extraction, physical separation and soil washing (An overall treatability report by BNL is expected by end of 1996).
- Bench-scale tests by WES on manufactured soil production, solidification/stabilization, physical separation, and dewatering processes (A report is expected by end of 1996).
- A pilot-scale field demonstration on manufactured soil production (using about 30% Harbor sediments plus saw dust, cow manure, and fertilizer and subsequent phytoremediation) is in progress.
- Pilot-scale demonstrations of technologies found to be most successful at bench scale are expected to be completed by the end of 1996.
- A document on the beneficial use of post-treated sediment is in preparation.
- Research on sediment toxicity identification evaluations (TIEs), linking the causes of toxicity from sediments with classes of chemical contaminants, is ongoing (Kuhn and others 1995, and Lebo and others 1996).
- A 3-dimensional visualization of contaminant distributions in Harbor sediments is being developed.
- Public meetings on project results and concerns are being held and literature disseminated.

HISTORICAL TRENDS

Historical trends in ocean disposal of wastes in the New York Bight include increases in scientific research, public concern and involvement, government oversight, and the use of non-ocean alternatives, and a dramatic decrease in ocean disposal activities. These trends are evidenced by table 10 which summarizes the history and regulation of the ocean disposal sites.

1800s to Late 1960s.-- In the past, the ocean has often been perceived as a limitless resource in which wastes could be disposed without affecting the ecological balance. The Bight has historically provided for many uses, including

food, recreation, transportation, and waste disposal. A great variety of wastes (including street sweepings, garbage, industrial wastes, construction and demolition debris, municipal sewage, and dredged material) have been generated by the densely populated New York City region and disposed in the Bight. And large quantities have been disposed; about 1,100 mcy of waste solids were estimated to have been disposed in the Bight between 1890 and 1971 (Gross 1976).

Many wastes from the New York City area were initially disposed in the Harbor, but these wastes tended to wash up onshore or cause shoaling that interfered with navigation. As a result, disposal shifted from the Harbor to inshore areas of the Bight and then progressively farther offshore in deeper Bight waters.

Although the ocean disposal of wastes had become a common practice by the late 1800s, there was very little regulation. What limited legislation existed was based primarily on transportation and navigation needs, rather than on environmental concerns. Congressional Acts (such as the New York Harbor Act of 1888, the Refuse Act of 1899, and the Rivers and Harbors Act of 1899) gave the USACE authority to select disposal sites and issue permits for ocean disposal.

The first major ban in ocean disposal activities occurred in the 1930s. Although the USACE had attempted to minimize washups of garbage and floatable debris with disposal schemes dependent on the tides and season, it was not successful. Following lengthy litigation between New York City and communities along the New Jersey shore, the Supreme Court banned the ocean disposal of municipal garbage and floatable debris in U.S. waters after 1934.

Late 1960s to Late 1980s.-- Public and Congressional awareness about the environmental impacts of ocean disposal increased dramatically in the late 1960s and early 1970s. Concern was aroused by:

- incidents involving warfare agents disposed at sea in 1968 and 1969 (EPA 1980b);
- studies on the effects of waste disposal in the Bight in the late 1960s (see National Marine Fisheries Service (NMFS) 1972);
- the Food and Drug Administration's closure of shellfish beds in a 160-square-mile area around the sewage sludge site because of high counts of coliform bacteria in 1974;
- the washups of tar and grease balls, charred wood, and plastic- and other floatable debris (including styrofoam cups, bottles, tampon inserters, and cigarette filters) on beaches of the Bight during the summer of 1976 (Squires 1983); and
- a major anoxic event and fishkill in the bottom waters over a large area off the New Jersey shore later that same summer (Squires 1983).

Table 10. History of use and regulation of ocean disposal sites in the NY Bight.

	History of Site Use and Regulation
Acid Waste	<ul style="list-style-type: none"> -First used in 1948 -Interim site designation in 1973 -EIS in 1980 -Final designation 1983 -No disposal since Sept 1988 -Dedesignated in 1991
Industrial Waste	<ul style="list-style-type: none"> (1) Deepwater 106-Mile Site <ul style="list-style-type: none"> -In use since 1961 -EPA first regulated in 1972 -EIS on 106-Mile Site in 1980 (2) Deepwater Industrial Waste Disposal Site (within 106-Mile Site) <ul style="list-style-type: none"> -Designated site in 1984 -Last disposal in 1987 -Dedesignated in 1990
Cellar Dirt	<ul style="list-style-type: none"> -In use since 1940 -Designated interim site in 1973 -EIS in 1982 -Final designation 1983 -No disposal since Nov 1989 -Dedesignated in 1994
Woodburning at Sea	<ul style="list-style-type: none"> -In use since mid-1960s -Volume records first kept in 1973 -Designated an interim site in 1977 -Draft EIS in 1989 -No disposal since 1991 -Proposed for dedesignation in Sept 1991 -Banned after 1993 under WRDA of 1990
Sewage Sludge	<ul style="list-style-type: none"> (1) 12-Mile Site <ul style="list-style-type: none"> -In use since 1924 -Designated an interim site in 1973 -EIS in 1978 -Final designation in 1979 -Phase-out began in 1986 and ended in Dec 1987 -Dedesignated in 1990 (2) Deepwater 106-Mile Site <ul style="list-style-type: none"> -In use since 1961 -EIS on 106-Mile Site in 1980 (3) Deepwater Municipal Sludge Dump Site (within 106-Mile Site) <ul style="list-style-type: none"> -Designated site in 1984 -Disposal began 1986 -No disposal since June 1992
Dredged Material	<ul style="list-style-type: none"> (1) Mud Dump Site (MDS) <ul style="list-style-type: none"> -Parts of MDS and vicinity in use since 1914 -Designated an interim site in 1973 -EIS in 1982 -Final designation in 1984 -Current status: preparation of Supplemental EIS (2) Inlet Sites <ul style="list-style-type: none"> -EIS in 1988 & sites designated in 1990 -Only small amounts disposed sporadically for beach nourishment

Although the washups and fishkill were not found to be caused by federally regulated ocean disposal, the public generally blamed ocean disposal of wastes, particularly sewage sludge, for these events. The growing public and Congressional concern about the ocean disposal of wastes led to laws that greatly increased research, public involvement, and government oversight. Two pieces of

legislation and an international agreement were key.

First, the National Environmental Policy Act (NEPA) was passed by Congress in 1969. This act resulted in a Council of Environmental Quality report (1970) which identified the poor regulation of ocean disposal as a potential environmental danger. It also led to the establishment of

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the EPA in 1970, and EPA was subsequently given oversight responsibility for many ocean disposal activities. In addition, NEPA requires EPA and other federal agencies to consider every environmental aspect of a proposed federal action, such as designating ocean disposal sites. Finally, NEPA requires the agencies to inform the public of potential impacts to the human environment and involve it in the NEPA decision-making process. Depending upon the circumstances of the environmental action, the preparation of an Environmental Impact Statement may be required. Although NEPA does not require the preparation of an EIS for the designation of an ocean disposal site, it is EPA's policy to do so voluntarily. As indicated in table 10, an EIS was prepared for each of the disposal sites in the Bight.

Second, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, commonly known as the London Dumping Convention (LDC), was negotiated in London in 1972 and went into effect in 1975. The LDC is an international agreement among nations to control materials leaving their shores for the purpose of ocean disposal. It prohibits the discharge into international waters of all high-level radioactive materials, and biological- and chemical warfare agents. It also prohibits certain toxic organic wastes (such as organohalides), persistent plastics, petroleum products, and wastes containing certain toxic metals (such as cadmium and mercury) except when present in trace amounts. Municipal garbage (previously banned in US waters) is also prohibited from being ocean disposed. The U.S. is one of almost 100 signatory nations. In accordance with the LDC, EPA reports the quantities of the different types of material disposed each year under the federal ocean disposal program. (Unfortunately for the purposes of this paper, these reports did not usually specify disposal in the Bight, but lumped together all disposal along the Atlantic coast.)

Third, the Marine Protection, Research, and Sanctuaries Act (MPRSA) (Public Law 92-532), also referred to as the Ocean Dumping Act, was passed in 1972 (and subsequently amended). This law is the domestic legislation for implementing the LDC. MPRSA declares that "it is the policy of the United States to regulate the dumping of all types of materials into ocean waters." It prohibits the ocean disposal of any material which would unreasonably degrade or endanger human health, welfare, amenities, the marine environment, ecological systems, or economic potentialities. MPRSA regulates the ocean disposal of other wastes by specifying and assigning research and monitoring responsibilities, site designation procedures, permitting procedures, and enforcement responsibilities under four separate federal agencies.

Research and monitoring the effects of ocean disposal is the shared responsibility of EPA and the National Oceanic and Atmospheric Administration (NOAA). NOAA, under its

Marine Ecosystem Analysis (MESA) research program, undertook a major effort, known as the New York Bight Project, to synthesize and sponsor research on the effects of human wastes on the Bight. A holistic approach was taken in which the Bight was treated as one ecosystem and the impacts of all sources of pollution were considered. Although ocean dumping had widely been assumed to cause the greatest impacts to the Bight, atmospheric and tributary inputs were found to contribute significantly. A symposium was held in 1979 to summarize the results of the project and to see if these results could be used to better manage ocean disposal and other sources of pollution in the Bight. The findings of this symposium and numerous papers and technical reports from the Bight project on ocean disposal may be found in the literature (Gross 1976, Mueller and Anderson 1978, Mayer 1982, and Squires 1983).

Evaluating and designating ocean disposal sites is the responsibility of EPA. Site designation involves preparation of a voluntary EIS and a thorough environmental review in accordance with site designation criteria outlined in the Ocean Dumping Regulations and Criteria that EPA first issued in October 1973. The site designation process is conducted to identify and select a location suitable for the type of material in question. The designation of a site does not authorize actual disposal operations, which may take place only if an ocean dumping permit is issued.

The permitting program established under MPRSA is administered by EPA and the USACE. The Ocean Dumping Regulations and Criteria specify procedures which must be followed in order to obtain an ocean disposal permit. The USACE issues permits to dispose of dredged material in ocean waters; EPA issues permits for ocean disposal of all other materials that comply with the ocean dumping criteria. Although dredged material disposal permits are issued by the USACE, EPA reviews all the permit applications to assure that the proposed disposal activities will be in compliance with the criteria specified in the regulations. It has been and continues to be EPA's policy that no permit should be issued for ocean disposal of any waste if there is a technically feasible and environmentally acceptable alternative disposal method. Interim designation was given and permits issued for sites in use at the time this legislation became effective. Those disposal sites in the Bight given interim designation included the Acid Waste Site, the Cellar Dirt Site, the Woodburning-at-Sea Site, the 12-Mile Municipal Sludge Dump Site, the Deepwater 106-Mile Site, the Mud Dump Site, and eight inlet sites. Following the implementation of MPRSA, the number of ocean dumping permits issued steadily declined and the ocean disposal of industrial wastes was phased out by many companies.

Surveillance and enforcement activities to ensure lawful ocean dumping practices are the responsibility of the U.S.

Coast Guard working in cooperation with EPA. Methods used in surveillance have included a requirement for advance notification before disposal, inspections of the dumping vessel in port, shipriders to observe the disposal operations, radar, and sea and air patrols.

Late 1980s to Mid-1990s.-- Numerous conferences and symposiums during this period brought together diverse interests from academia, government, industry, environmental groups, and the public to resolve ocean disposal issues (for example, see EPA 1990b and NOAA 1995). This period also saw increasing government monitoring, more stringent permit conditions, and increased use of beneficial and other non-ocean alternatives so that the quantities of ocean-disposed wastes continued to decline. Various events increased public concern about the ocean disposal of wastes and resulted in legislation that banned the disposal of certain wastes in ocean waters. The washup of medical waste and other floatable debris on beaches in New Jersey and New York during of 1987 and 1988 was one of these events. Although subsequent investigations did not link these washups (or the 1976 one) with the ocean disposal of wastes, heightened public concern led to the passage of the Ocean Dumping Ban Act in 1988 (Hunt and others 1994). This act banned all ocean disposal of municipal sewage sludge and industrial waste. Public concern over woodburning at sea, visible from the New Jersey shore, led to the passage of the Water Resources Development Act (WRDA) of 1990, an act which banned woodburning at sea. Almost all ocean disposal activities in the Bight were phased out by the early 1990s: Industrial waste disposal ended in 1987, acid waste in 1988, cellar dirt in 1989, wood incineration in 1991, and sewage sludge in 1992.

CONCLUSION

The federal ocean disposal program in the Bight has changed dramatically in the last 25 years. Public and Congressional concern about the environmental impacts of ocean disposal resulted in legislation that brought about many of the changes. Comprehensive research programs were set up to gain an understanding of the natural processes of the Bight and the impacts of waste disposal. Academia, government agencies, environmental groups, and industry were brought together in workshops, symposiums, and public meetings. The EPA was established and government oversight greatly increased. Materials were tested prior to disposal, stringent permit conditions imposed, management plans developed, and monitoring studies conducted. Disposal strategies, such as dilute-and-disperse for (mostly) liquid wastes like sewage sludge and contain-and-isolate strategies for solids like dredged material, were adopted. The technical feasibility, the costs, and the environmental impacts of non-ocean alternatives were evaluated and compared. Waste minimization, beneficial reuse and recycling was encouraged. The federal ocean disposal programs for

industrial waste, acid waste, cellar dirt, wood incineration, and sewage sludge were phased out. Dredged material, the one remaining program, is highly regulated.

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